TRAFFIC SPEED REPORT 78

TRUCK SPEED-WEIGHT STUDY

JANUARY 1964

NO. 1

by

L.L. SCHULMAN

Joint Highway Research Project

PURDUE UNIVERSITY
LAFAYETTE INDIANA

Progress Report

"Traffic Speed Report No. 78"

TO: K. B. Woods, Director
Joint Highway Research Project

December 1[illegible] 1963

FROM: H. L. Michael, Associate Director
Joint Highway Research Project

File: 8-3-4
Project: C-36-[illegible]

Attached is a Progress Report entitled "Traffic Speed Report No. 78". The results of the 1963 study of the relationship between truck weights and truck speeds are contained herein. The report has been prepared by Mr. L. L. Schulman, graduate assistant on our staff, and was prepared from data obtained during the annual truck study performed by the Highway Planning Survey Section of the Indiana State Highway Commission. The Project has cooperated in this study in a similar manner for many years.

Participation in this study by personnel of the Project was not as great this year as in previous years as the study was conducted about one month later this year thereby causing many conflicts with the beginning of classes for our personnel.

This report will be distributed in the usual manner to the Highway Commission, the Bureau of Public Roads, the State Police, the Office of Traffic Safety and the Traffic Safety Foundation. It is presented to the Board for information and for the record and for approval of such distribution.

Respectfully submitted,

Harold L. Michael, Secretary

HLM:bc

Attachment

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Progress Report

TRAFFIC SPEED REPORT NO. 78

by

Lawrence Schulman
Graduate Assistant

Joint Highway Research Project

File No: 8-3-4

Project No: C-36-10D

Purdue University

Lafayette, Indiana

December 17, 1963

TRAFFIC SPEED REPORT NO. 78

Introduction

This report is an analysis of the 1963 annual truck speed-weight study conducted during the months of August and September in conjunction with the Highway Planning Survey Unit of the Indiana State Highway Commission. The Highway Planning Survey Unit makes annual studies of truck weights, size, material hauled and this year included an origin and destination study. Personnel of the Joint Highway Research Project observe the speeds of the trucks at some point along the road and by use of an identical method of classification match the truck weight and speed. Although the Highway Planning Survey Unit makes its observations at twenty locations throughout the state, nine stations have been used annually for the speed-weight study by the Project.

This year, due to a very late data collection schedule, the Project was unable to collect data at all nine of the usual stations. Consequently this report is for only six of the nine stations usually observed. The stations utilized are shown on Figure 1 and are further described as follows:

Station	Highway	Location	Date of obs.	No. of Lanes
58B	U.S. 31	0.2 mi S of Southport Road	Aug. 20	4
75	U.S. 41	0.2 mi S of U.S. 41 Bus.	Aug. 21	4
81	U.S. 150	0.5 mi E of S.R. 56	Aug. 23	2
45B	S.R. 67	1.0 mi SW of Muncie	Aug. 29	2
5*	U.S. 30	1.3 mi E of Burbon	Sept. 23	2
4*	U.S. 31	0.2 mi S of U.S. 6	Sept. 24	2
2*	U.S. 20	0.3 mi W of S.R. 2	Sept. 20	4
14	U.S. 41	0.5 mi S of S.R. 2	Sept. 11	4
42	U.S. 52	at Jct. of S.R. 38	Sept. 16	4

*Not observed in 1963.

Equipment and Field Procedure

The speed data were collected by use of the Electromatic Radar Speed Meter-Model No. S-5. Prior to conducting the study, the Meter had been checked for accuracy by use of a fifth wheel device, and during the study the meter was periodically tested to insure continued accuracy by use of 30 mph and 45 mph tuning forks.

To lessen the effect of the observer on the traffic stream, the meter was placed in a cardboard barrel near the roadway and the observer and recording unit were stationed at least twenty feet from the edge of the roadway. Complete concealment was not found to be practical on modern highways having wide shoulders. The meter was placed approximately three feet from the edge of the pavement at an angle of less than 10° with the centerline of the roadway. Speed inaccuracies are negligible at small angles and corrections were unnecessary.

The speed observations were made on level, tangent sections of the highway between one and three miles from the weighing stations. In all cases, sufficient distance was allowed for the trucks to regain normal cruising speeds since data were desired for "free-moving vehicles." For this report "freemoving vehicle" refers to one which is not hampered by other traffic or effected by a change in speed due to stopping or turning. Care was also taken to minimize the opportunity for the vehicle to turnoff the road.

The speed stations were operated during the same hours as the weighing stations, 8 a.m. to 4 p.m. During the four morning hours the observations were made on vehicles moving in one direction and during the four afternoon hours the apparatus was moved to the other side of the roadway to observe vehicles in the opposite direction.

Procedure and Analysis

For purpose of the analysis the data were classified by truck type - single unit or multi-unit - and by road type - two lane or four lane. The single unit trucks were further classified into those less than 5000 lbs. and those over 5000 lbs. This weight classification corresponds to the existing Indiana speed limits for trucks which are as follows:

65 mph for light (less than 5000 lbs.) trucks

55 mph for heavy (over 5000 lbs.) trucks on 4-lane highways with a median of 20 ft. or more

50 mph for heavy trucks on other roadways

This classification allowed a comparison of the observed speeds with the legal and "enforced" speed limits. These results are presented in tabular form in Table III.

A breakdown of the data is presented in Tables I and II. The observed values are separated into weight classes and the number observed and average speed within each weight class is shown. The tables also show the average weight, average speed and 95% confidence limits for each truck classification at each station and summaries by truck classification on both types of highway facility. Table IV is a tabulation of the number of observations and average speeds and weights by truck classification for the last fifteen years.

Figures II, III, and IV are cumulative frequency curves by truck classification and by facility type. Figures V and VI indicates the trends in 85th percentile speeds. Figures VII-IX show simple regression curves of truck speed to truck weight.

Summary of Results

Analysis of Tables I and II show the following average characteristics for the various road and truck classifications:

Single Unit

	2-lane	4-lane	All
No. of Vehicles	167	321	488
Average Speed - mph	41.7	46.2	44.9
Average Weight - lbs	10,300	12,000	11,500

Multi-unit

	2-lane	4-lane	All
No. of Vehicles	126	610	736
Average Speed - mph	42.9	46.4	45.9
Average Weight - lbs	40,170	44,280	43,600

Table III shows that the following percentages of trucks exceeded the existing and enforced speed limits (where the enforced speed limit is 5 miles faster than the legal speed limit).

		Single Unit		Multi-unit
		Light	Heavy	
2-lane	Speed Limit	0	7.2	7.9
	Enforced limit	0	.7	.8
4-lane	Speed limit	0	.8	5.3
	Enforced limit	0	2.1	.5

From the above table one can conclude that there is a negligible percentage of trucks exceeding the "enforced" speed limit on Indiana highways.

Observation of the steepness of the central portion of the cumulative frequency curves (Fig. II, III, IV) for the heavier trucks indicates that a smaller variation in speeds exist between heavy trucks than between light trucks. These figures also show that the greatest variation in the confidence band for the calculated means occurs for light, single-unit trucks. This may be an indication of too small a sample size in comparison with the other classifications.

Figures V and VI show the plots of the 85th percentile speeds on 2-lane and 4-lane. No trend regression lines have been drawn since the data are widely scattered.

Figures VII-IX show the computed regression lines and equations for the simple linear regression analysis of the speed and weight data. This analysis was done on the LGP-30. These figures show that there is a slight decrease in speed for an increase in weight, but the decrease in most cases is insignificant. Furthermore the r^2 values or the correlation coefficient show that there is little correlation between speed and weight. If a perfect correlation existed, the r^2 value would be 1. In this study the computed r^2's between speed and weight were as follows:

Equation	r	r^2
2-lane single unit	.0355	.0012
4-lane single unit	.2092	.0437
2-lane multi unit	.0972	.0094
4-lane multi unit	.1853	.0343
Multi unit (total)	.1465	.0214
Single unit (total)	.1048	.0109

It should be noted that the sample size for many of the weight classifications was too small to give a reliable regression line for sample unit trucks and that the largest correlation coefficient observed for multi-unit or total truck classifications was .0343. This indicates little correlation. It can, therefore, be concluded that increasing weight apparently accounts for only a very small part of the observed speed differences.

Table IV indicates that the average speeds of single unit and multi-unit trucks have decreased 3.8 and 3.3 mph respectively from the last observation. This represents a substantial decrease from the slowly rising trend in average speeds which has been occuring. Closer observation also shows that speeds at each of the six stations were in most cases 2-5 mph less for all classes of trucks then they were last year.

Because of this unusual decrease, the radar meter was again calibrated after the study to determine if any operational error was present. The calibration was made by running a vehicle at known speeds past the meter. The results showed that no error existed.

Part of the decrease in the overall average may be due to not observing the three stations in Northern Indiana which in the past have given slightly higher speeds. This is especially true of the 2-lane roadways. However, no explanation is apparent for the observed decrease at each of the individual stations.

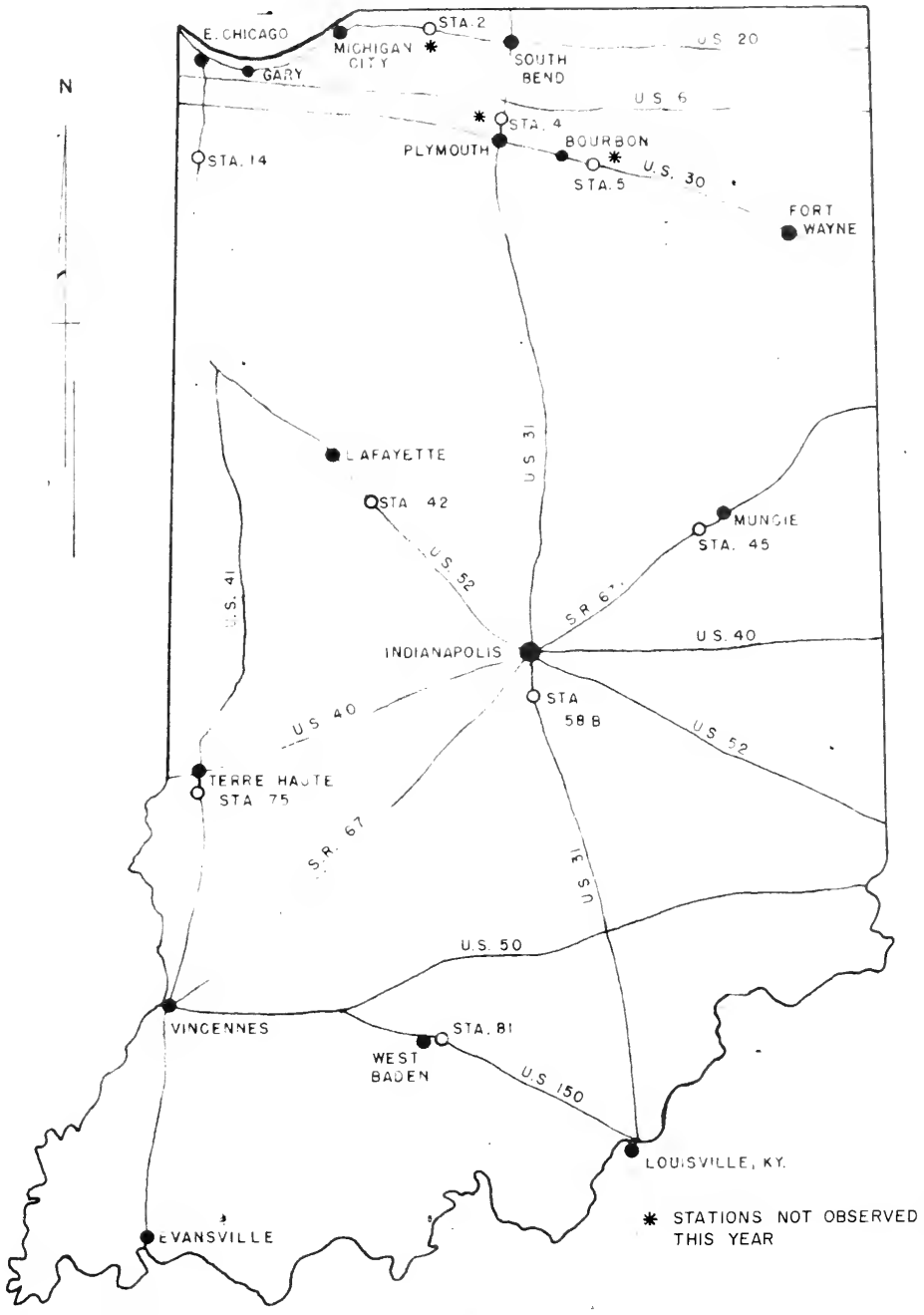
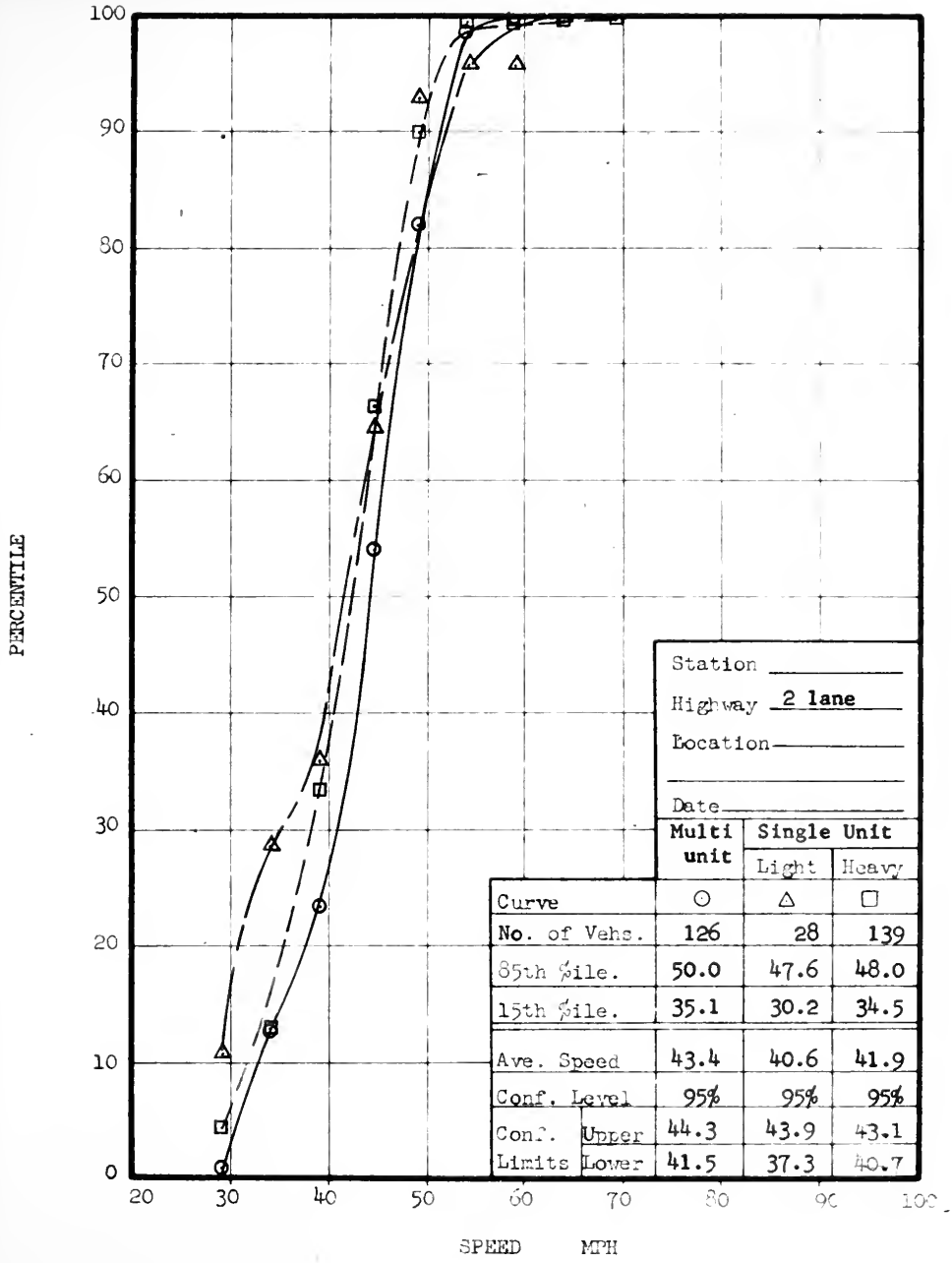


FIG. 1 LOCATIONS OF TRUCK WEIGHT - SPEED STATIONS



	Multi unit	Single Unit	
		Light	Heavy
Curve	⊙	△	□
No. of Vehs.	126	28	139
85th %ile.	50.0	47.6	48.0
15th %ile.	35.1	30.2	34.5
Ave. Speed	43.4	40.6	41.9
Conf. Level	95%	95%	95%
Conf. Limits Upper	44.3	43.9	43.1
Conf. Limits Lower	41.5	37.3	40.7

FIGURE II

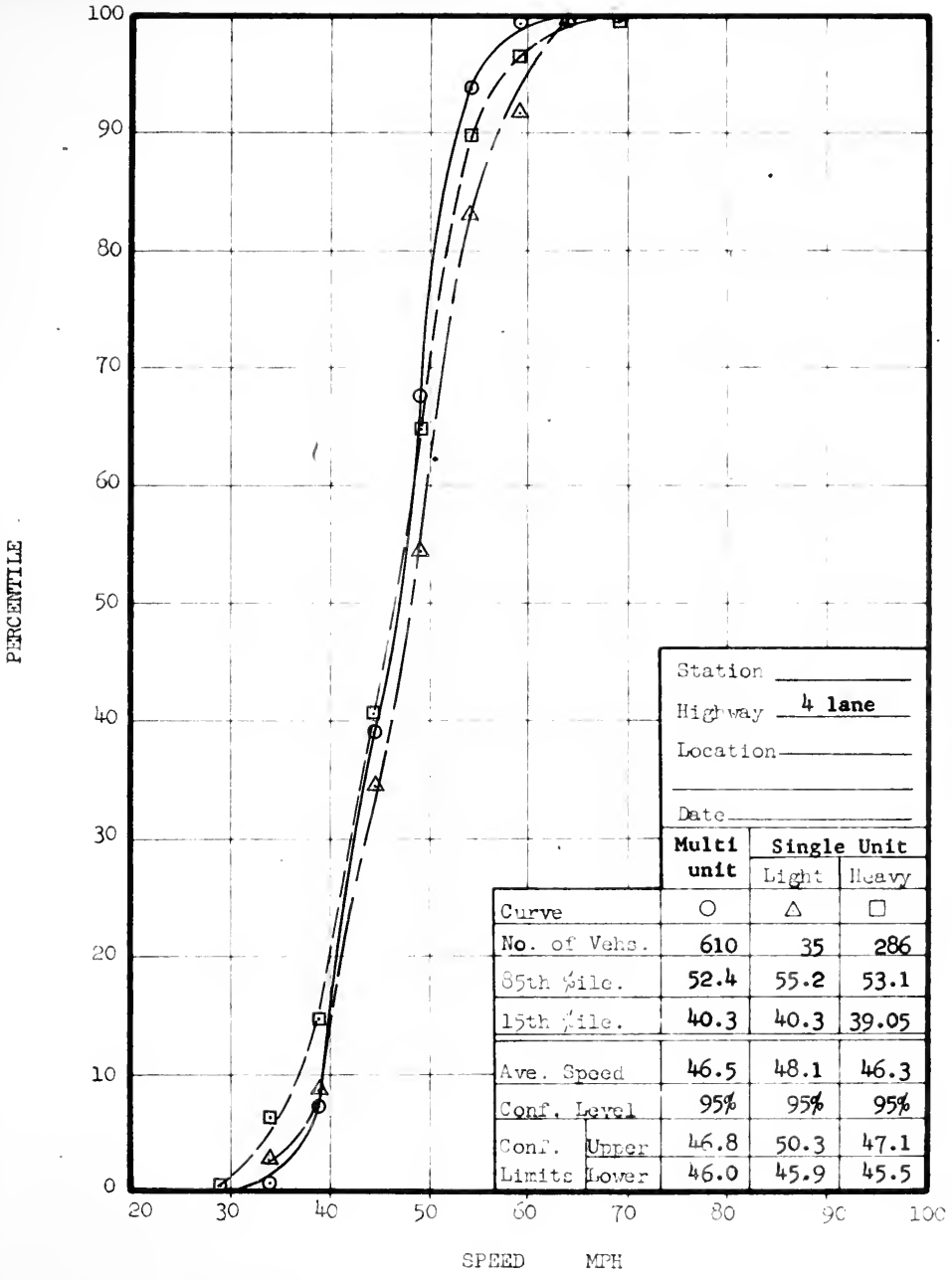
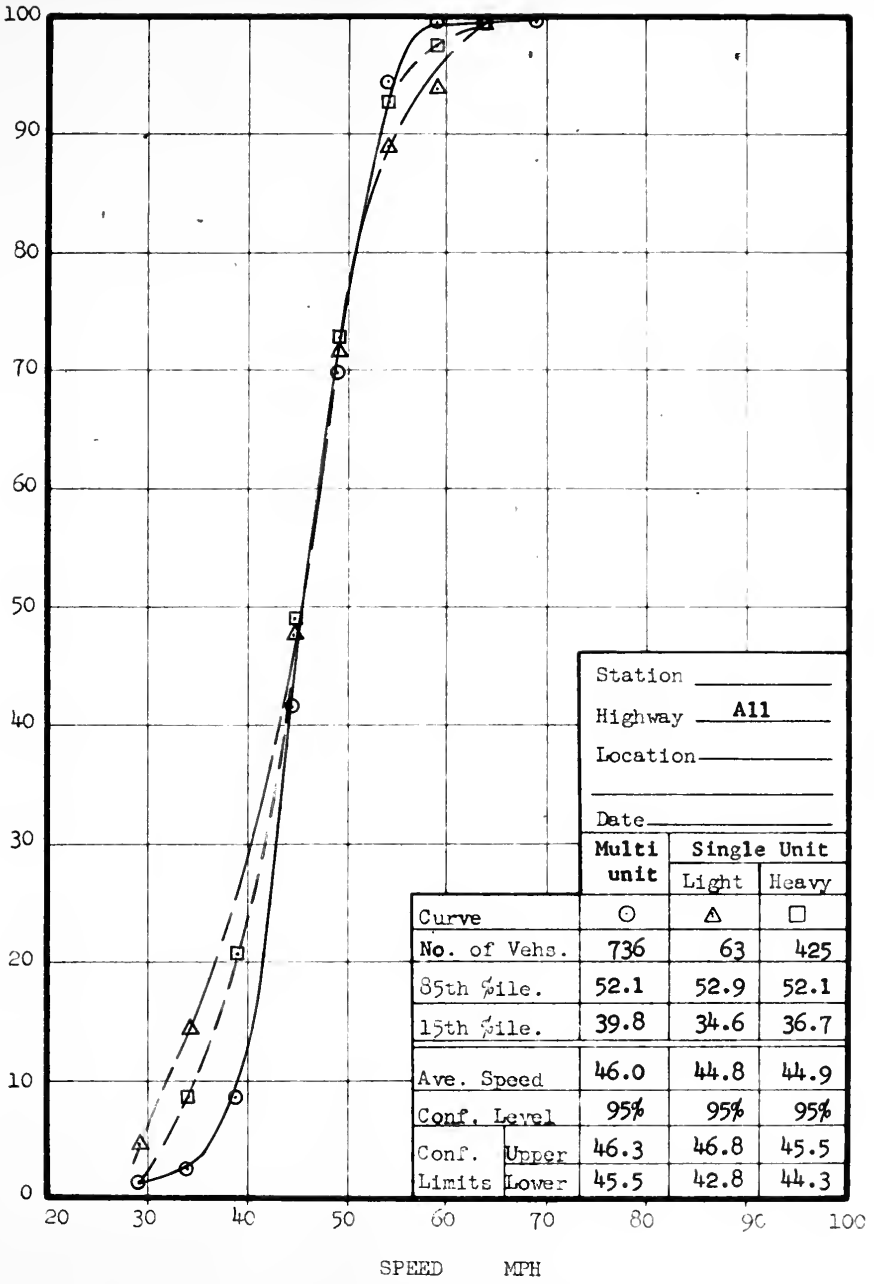

PERCENTILE
100
90
80
70
60
50
40
30
20
10
0
20
30
40
50
60
70
80
90
100
SPEED MPH
Station
Highway 4 lane
Location
Date
Multi unit
Single Unit
Light
Heavy
Curve ○ △ □
No. of Vehs. 610 35 286
85th %ile. 52.4 55.2 53.1
15th %ile. 40.3 40.3 39.05
Ave. Speed 46.5 48.1 46.3
Conf. Level 95% 95% 95%
Conf. Limits Upper 46.8 50.3 47.1
Lower 46.0 45.9 45.5

FIGURE III



Curve	Multi unit ○	Single Unit Light △	Single Unit Heavy □
No. of Vehs.	736	63	425
85th %ile.	52.1	52.9	52.1
15th %ile.	39.8	34.6	36.7
Ave. Speed	46.0	44.8	44.9
Conf. Level	95%	95%	95%
Conf. Limits Upper	46.3	46.8	45.5
Conf. Limits Lower	45.5	42.8	44.3

FIGURE IV

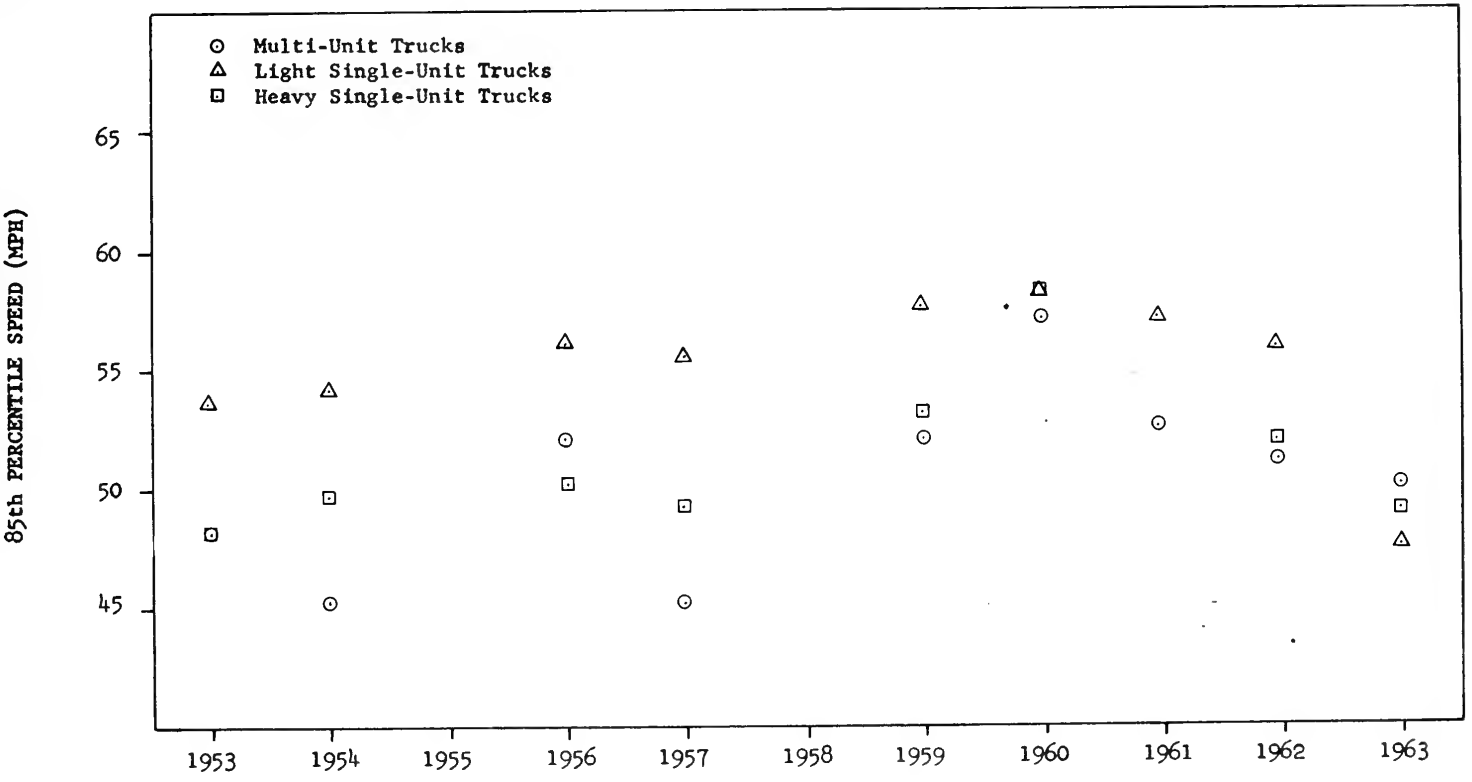


FIGURE V TRENDS IN THE 85th PERCENTILE TRUCK SPEED ON TWO-LANE HIGHWAY (1953-1963)

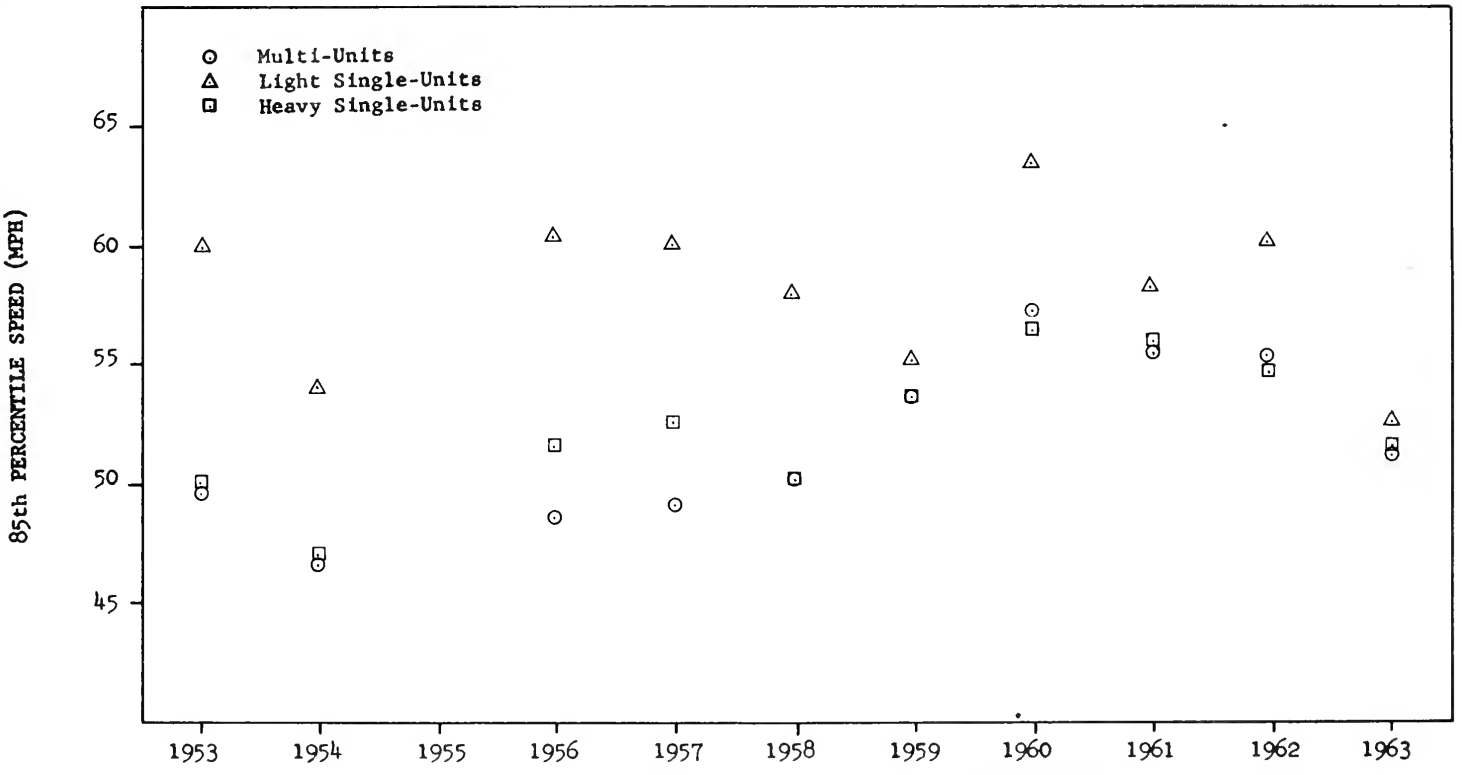


FIGURE VI TRENDS IN 85th PERCENTILE TRUCK SPEEDS ON FOUR-LANE HIGHWAYS (1953-1963)

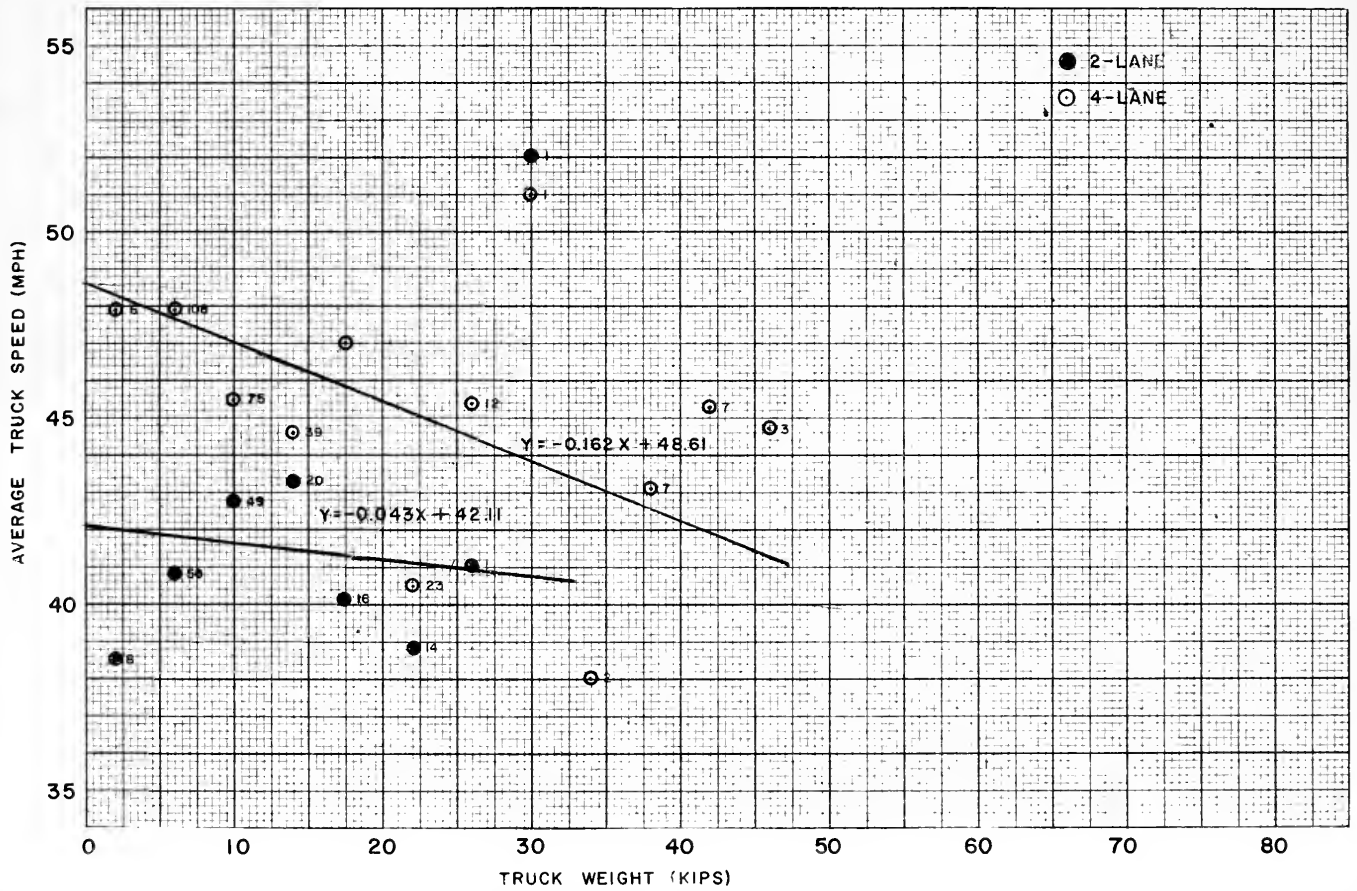


FIGURE VII REGRESSION ANALYSIS: SINGLE UNIT TRUCKS BY ROADWAY TYPE

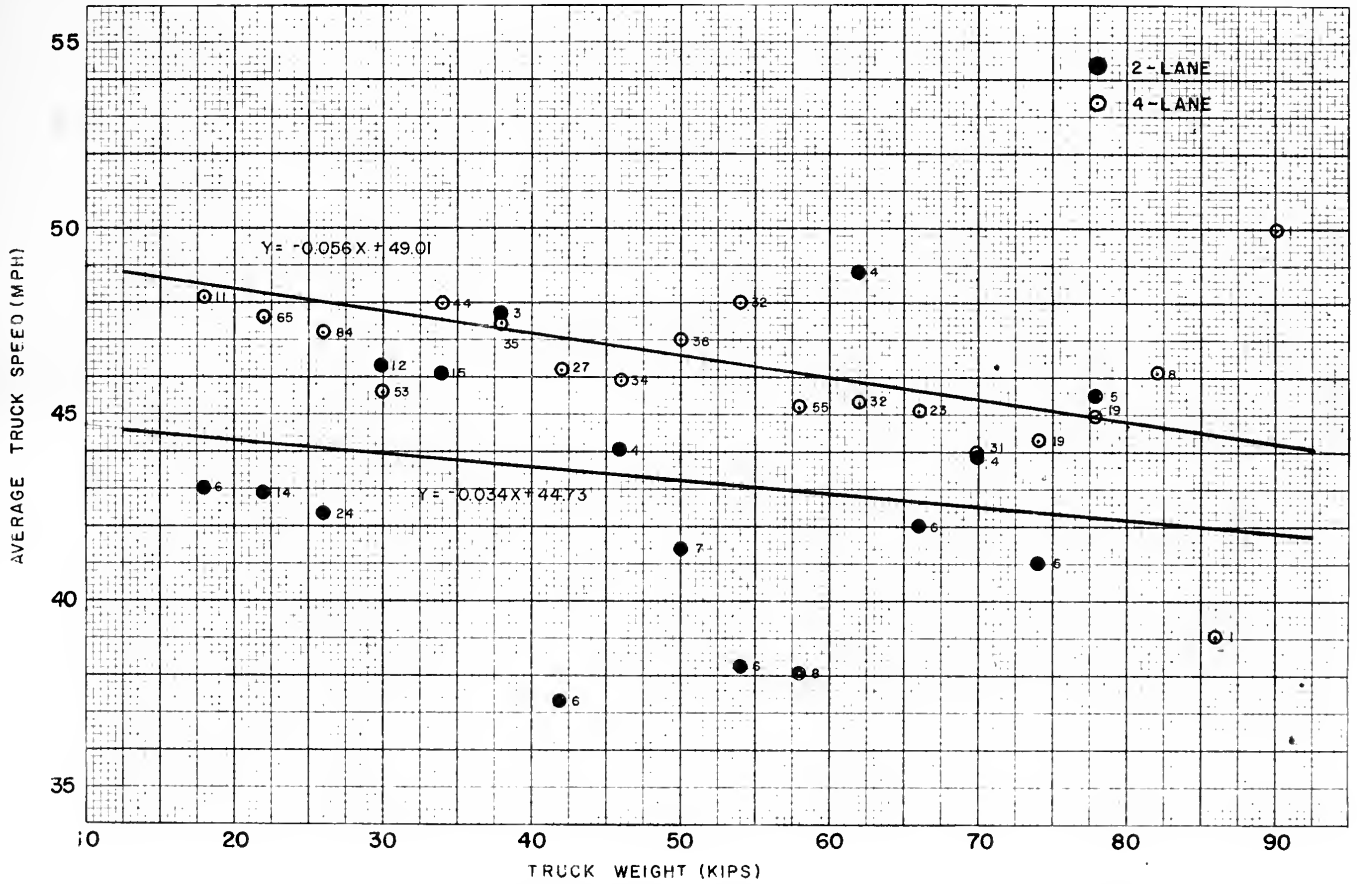


FIGURE VIII REGRESSION ANALYSIS: MULTI UNIT TRUCKS BY ROADWAY TYPE

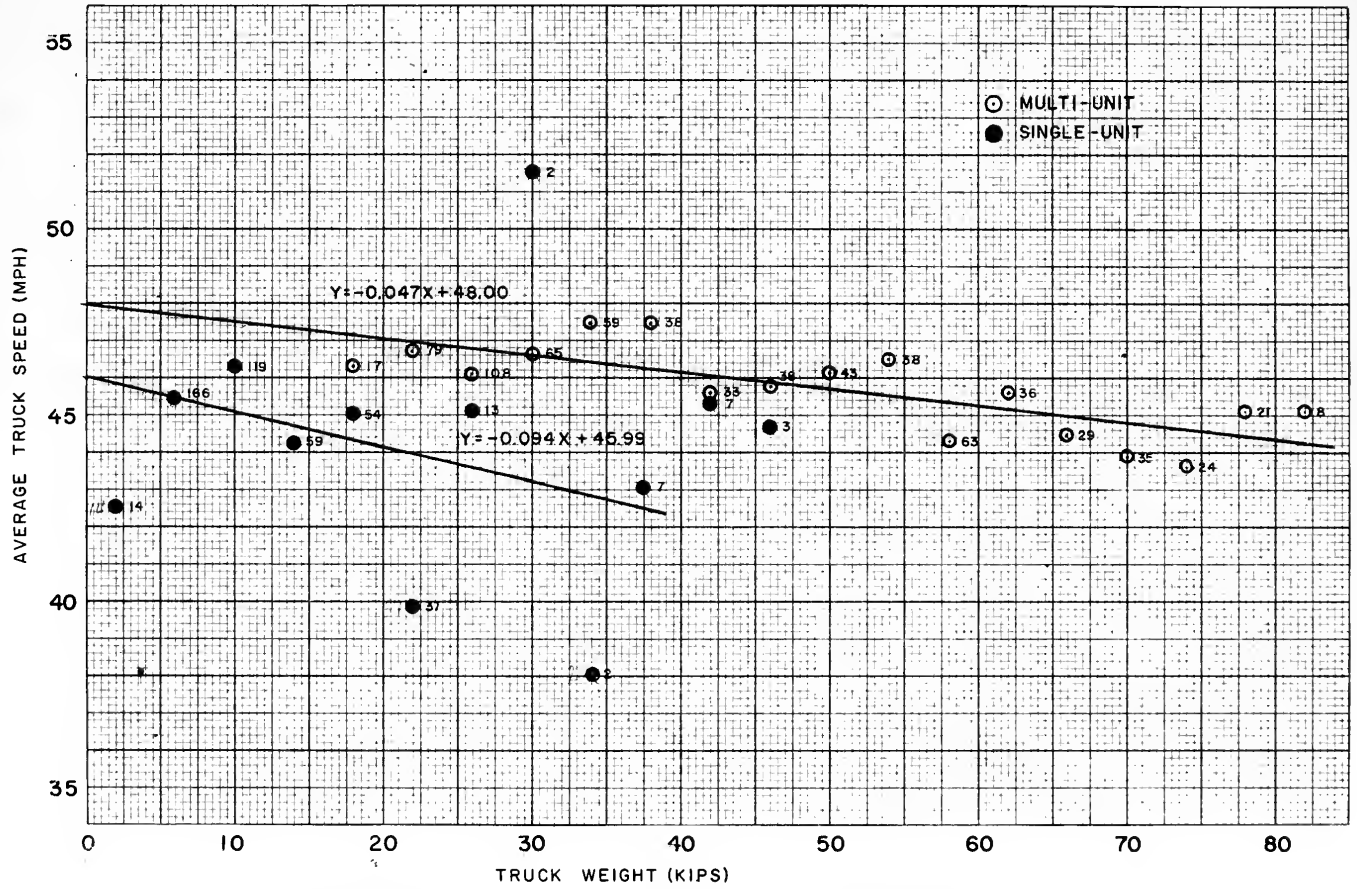


FIGURE IX REGRESSION ANALYSIS: ALL TRUCKS BY TRUCK TYPE

Station	45B							
Weights (Kips)	Ave. Speed	No. of Trucks						
0-4	0	0	3	47.7	3	47.9	6	42.5	14
4-5	46.0	6	0	46.2	14	48.2	29	45.5	49
Total Trucks	6			17		35		63	
Ave. Wt. (Lbs.)	4300			4400		4300		4200	
Ave. Speed	46.0			46.5		48.1		44.8	
Confid. Level	95%			95%		95%		95%	
Confid. Limit Upper	48.4			48.2		50.3		46.8	
Confid. Limit Lower	43.6			44.8		45.9		42.8	
% Empty									
5-6	46.7	13	1	45.9	23	47.8	79	45.4	117
6-7	46.6	19	4	44.3	28	45.5	75	46.3	124
10-10	46.7	11	11	44.9	10	44.6	39	44.2	59
10-8	43.6	5	9	44.6	7	47.0	38	45.0	54
20-24	46.5	2	4	37.9	14	40.5	23	39.9	37
24-28	0	0	1	40.0	3	45.4	12	45.1	13
28-32	52.0	1	0	51.0	1	51.0	1	51.5	2
32-36			1	38.0	1	38.0	2	38.0	2
36-40			5	32.0	1	43.1	7	43.1	7
40-44			6	0	0	45.3	7	45.3	7
44-48			2	35.0	1	44.7	3	44.7	3
48-52									
52-56									
56-60									
Total Trucks	51			89		286		425	
Ave. Wt. (Lbs.)	11,300			10,200		13,100		12,600	
Ave. Speed	46.5			43.4		46.3		44.9	
Confid. Level	95%			95%		95%		95%	
Confid. Limit Upper	47.9			45.0		47.1		45.5	
Confid. Limit Lower	45.1			41.8		45.5		44.3	
% Empty									

TABLE I SPEED-UNIT TRUCK (MPH)

Station	Two-lane Highways										Four-lane Highways										Total Two-lane and Four-lane	
	45B						81		Total Two-lane			1/		2	45B		72		Total Four-lane			
	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks
0-5	0	0					38.5	8	38.5	8		0	0	0	0	48.0	3	47.7	3	47.9	6	42.5	14
5-10	46.0	6					39.5	14	41.5	20		43.0	1	50.8	4	50.4	10	46.2	14	48.2	29	45.5	49
Total Trucks	6						22		28			1		4		13		17		35		63	
Average (Est.)	4300						4000		4100			4200		4500		4300		4400		4300		4200	
Mean Speed	46.0						39.1		40.6			43.0		50.8		49.8		46.5		48.1		44.8	
85% Point	95%						95%		95%			95%		95%		95%		95%		95%		95%	
85% Upper	48.4						43.0		43.9			43.0		58.3		53.3		48.2		50.3		46.8	
85% Lower	43.6						35.2		37.3			43.0		43.3		46.3		44.8		45.9		42.8	
Empty																							
0-5	46.7	13					39.0	25	40.5	38		50.1	7	52.4	8	48.9	41	45.9	23	47.8	79	45.4	117
5-10	46.6	19					40.3	30	42.8	49		51.6	8	47.8	25	47.8	14	44.3	28	45.5	75	46.3	124
10-15	46.7	11					39.1	9	43.3	20		46.0	7	44.7	11	43.5	11	44.9	10	44.6	39	44.2	59
15-20	43.6	5					38.5	11	40.1	16		52.8	4	47.4	8	46.5	19	44.6	7	47.0	38	45.0	54
20-25	46.5	2					37.5	12	38.8	14		45.3	3	44.5	2	44.0	4	37.9	14	40.5	23	39.9	37
25-30	0	0					41.0	1	41.0	1		47.2	5	47.7	3	46.0	1	40.0	3	45.4	12	45.1	13
30-35	52.0	1							52.0	1				0	0	0	0	51.0	1	51.0	1	51.5	2
35-40														0	0	38.0	1	38.0	1	38.0	2	38.0	2
40-45														50.0	1	44.0	5	32.0	1	43.1	7	43.1	7
45-50														41.0	1	46.0	6	0	0	45.3	7	45.3	7
50-55																49.5	2	35.0	1	44.7	3	44.7	3
55-60																							
60-65																							
65-70																							
Total Trucks	51						88		139			34		59		104		89		286		425	
Average (Est.)	11,300						11,700		11,600			14,500		13,700		15,000		10,200		13,100		12,600	
Mean Speed	46.5						39.2		41.9			49.4		47.6		47.0		43.4		46.3		44.9	
85% Point	95%						95%		95%			95%		95%		95%		95%		95%		95%	
85% Upper	47.9						40.4		43.1			51.8		48.8		54.9		45.0		47.1		45.5	
85% Lower	45.1						38.0		40.7			47.0		46.4		39.1		43.8		45.5		44.3	
Empty																							

Station	458			75		Total Four-lane		Total Two-lane and Four-lane	
Weight (Kips)	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	
8-12									
12-16									
16-20	44.5	4	42.0	1	48.1	11	46.3	17	
20-24	46.5	6	48.4	10	47.6	65	46.7	79	
24-28	44.4	14	45.0	9	47.2	84	46.1	108	
28-32	46.3	12	43.9	10	45.6	53	46.6	65	
32-36	48.6	10	44.3	4	48.0	44	47.5	59	
36-40	47.7	3	45.3	4	47.5	35	47.5	38	
40-44	38.0	5	---	---	46.2	27	44.6	33	
44-48	45.0	4	46.0	2	45.9	34	45.8	38	
48-52	45.5	4	47.0	1	47.0	36	46.1	43	
52-56	44.6	3	45.3	3	48.0	32	46.5	38	
56-60	43.0	2	42.7	7	45.2	55	44.3	63	
60-64	48.8	4	46.0	9	45.3	32	45.6	36	
64-68	43.5	4	48.7	6	45.1	23	44.5	29	
68-72	45.3	3	44.4	5	43.9	31	43.9	35	
72-76	53.0	1	42.5	2	44.3	19	43.6	24	
76-80	46.5	2	45.8	5	45.0	19	45.1	21	
80-84			46.5	2	46.1	8	46.1	8	
84-88					39.0	1	39.0	1	
88-92					50.0	1	50.0	1	
92-96									
96-100									
Total Trucks	81		80		610		736		
Ave. Wt.(Lbs.)	39,600		46,900		44,300		43,600		
Ave. Speed	45.5		45.4		46.4		45.9		
Conf. Level	95%		95%		95%		95%		
Conf. Limit Upper	47.5		46.4		46.8		46.3		
Conf. Limit Lower	43.5		44.4		46.0		45.5		
% Empty									

TABLE II MULTI-UNIT TRUCK SPEEDS (MPH)

Station	Two-lane Highways								Total Two-lane		Four-lane Highways										Total Four-lane		Total Two-lane and Four-lane	
	193		5		4		81				3		14		42		58		75					
Weight (kips)	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks
1-15																								
16-19																								
20-24	44.5	4					40.0	2	43.0	6			51.0	6	45.0	2	45.5	2	42.0	1	48.1	11	46.3	17
25-29	46.5	6					40.1	8	42.9	14			47.4	16	47.6	22	47.2	17	48.4	10	47.6	65	46.7	79
30-34	44.4	14					39.3	10	42.3	24			47.4	30	45.7	26	50.2	19	45.0	9	47.2	84	46.1	108
35-39	46.3	12					---	---	46.3	12			47.1	14	48.4	18	45.5	11	43.9	10	45.6	53	46.6	65
40-44	48.6	10					40.1	5	46.1	15			50.9	12	47.1	22	48.0	6	44.3	4	48.0	44	47.5	59
45-49	47.7	3					---	---	47.7	3			50.1	14	48.6	8	43.2	9	45.3	4	47.5	35	47.5	38
50-54	38.0	5					34.0	1	37.3	6			45.0	8	45.7	11	48.0	8	---	---	46.2	27	44.6	33
55-59	45.0	4					---	---	45.0	4			46.9	12	44.1	10	46.3	10	46.0	2	45.9	34	45.8	38
60-64	45.5	4					36.0	3	41.4	7			48.7	14	48.0	11	43.6	10	47.0	1	47.0	36	46.1	43
65-69	44.6	3					32.0	3	38.3	6			49.5	13	46.8	9	48.0	7	45.3	3	48.0	32	46.5	38
70-74	43.0	2					36.3	6	38.0	8			47.9	20	45.8	12	42.4	16	42.7	7	45.2	55	44.3	63
75-79	48.8	4					---	---	48.8	4			45.8	13	46.3	6	40.2	4	46.0	9	45.3	32	45.6	36
80-84	43.5	4					39.0	2	42.0	6			46.7	11	40.0	2	38.0	4	48.7	6	45.1	23	44.5	29
85-89	45.3	3					39.0	1	43.8	4			47.3	8	47.7	3	41.3	15	44.4	5	43.9	31	43.9	35
90-94	53.0	1					38.0	4	41.0	5			47.9	8	41.3	3	41.7	6	42.5	2	44.3	19	43.6	24
95-99	46.5	2							46.5	2			44.5	6	44.9	8			45.8	5	45.0	19	45.1	21
100-104													45.3	4	47.5	2			46.5	2	46.1	8	46.1	8
105-109													---	---	39.0	1					39.0	1	39.0	1
110-114													50.0	1							50.0	1	50.0	1
115-119																								
120-124																								
Total Trucks	81						45		126				210		176		144		80		610		736	
Ave. Wt. (Kips)	39,600						41,200		40,200				45,700		41,400		44,300		46,900		44,300		43,600	
Ave. Speed	45.2						38.3		42.9				47.8		46.5		45.1		45.4		46.4		45.9	
Conf. Level	95%						95%		95%				95%		95%		95%		95%		95%		95%	
Conf. Limit Upper	47.5						39.7		44.3				48.6		47.1		46.3		46.4		46.8		46.3	
Conf. Limit Lower	43.5						36.9		41.5				47.0		45.9		43.9		44.4		46.0		45.5	
% Empty																								

		Single Units						Multiple Units		
		Trucks Weighing Under 5000 lbs.			Trucks Weighing Over 5000 lbs.					
	Station	No. Obs.	% Exceed 65 mph	% Exceed 70 mph	No. Obs.	% Exceed 50 mph	% Exceed 55 mph	No. Obs.	% Exceed 50 mph	% Exceed 55 mph
Two-Lane Highways	45-B	6	0	0	51	17.6	2.0	81	12.3	1.2
	5	---	---	---	---	---	---	---	---	---
	4	---	---	---	---	---	---	---	---	---
	81	22	---	---	88	1.1	0	45	0	0
	Total	28	0	0	139	7.2	.7	126	7.9	0.8
		No. Obs.	% Exceed 65 mph	% Exceed 70 mph	No. Obs.	% Exceed 55 mph	% Exceed 60 mph	No. Obs.	% Exceed 55 mph	% Exceed 60 mph
Four-Lane Highways	2	---	---	---	---	---	---	---	---	---
	14	1	0	0	34	14.7	5.9	210	8.1	0.5
	42	4	0	0	59	5.1	3.4	176	2.3	0.6
	58-B	13	0	0	104	6.7	1.9	144	4.2	0.7
	75	17	0	0	89	10.1	0	80	2.5	0
	Total	35	0	0	286	8.4	2.1	610	4.8	0.5
	Summary	63	0	0	425	8.0	1.6	736	5.3	0.5

TABLE III

PERCENT OF TRUCKS VIOLATING SPEED LIMITS